



RESEARCH CENTER

FIELD

**Applied Mathematics, Computation
and Simulation**

Activity Report 2017

Section Contracts and Grants with Industry

Edition: 2018-02-19

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ACUMES Project-Team (section vide)

CAGIRE Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

EDF: "Advanced modelling of heat transfer for industrial configurations with or without accounting of the solid wall", contract associated to the PhD thesis of Gaëtan Mangeon

EDF: "Hybrid RANS/LES modelling for unsteady loadings in turbulent flows", contract associated to the PhD thesis of Vladimir Duffal

IFPEN: "3D simulation of non-reactive internal aerodynamics of spark-ignition engines using an hybrid RANS/LES method", contract associated to the PhD thesis of Hassan Al Afailal

PSA: ""Turbulence modelling in the mixed and natural convection regimes in the context of automotive applications", contract associated to the PhD thesis of Saad Jameel.

8.2. Bilateral Grants with Industry

EDF (Cifre PhD grant): "Advanced modelling of heat transfer for industrial configurations with or without accounting of the solid wall", PhD student: Gaëtan Mangeon

EDF (Cifre PhD grant): "Hybrid RANS/LES modelling for unsteady loadings in turbulent flows", PhD student: Vladimir Duffal

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PSA (Cifre PhD grant): "Turbulence modelling in the mixed and natural convection regimes in the context of automotive applications", PhD student: Saad Jameel.

CARDAMOM Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- THALES, Activity around the numerical certification of debris codes, Coordinator: P.M. Congedo, 23 Keuros ;
- ArianeGroup, Activity around techniques for computing low-probabilities, Coordinator: P.M. Congedo, 20 Keuros ;
- CEA-CESTA, Coordinator: P.M. Congedo, 40 Keuros ;
- An open-source consortium have been created around the Mmg platform. There are 3 members for 2017 :
 - SAFRAN Tech, silver member, 20Keuros ;
 - "Environnement des codes" laboratory, CEA-Cesta, silver member, 3Keuros ;
 - Coria laboratory, INSA Rouen, silver member, 3Keuros.

DEFI Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

- A CIFRE PhD thesis started January 2015 with Dassault Aviations. The student is M. Aloïs Bissuel who is working on "linearized Navier-Stokes equations for optimization, fluttering and aeroacoustic".
- A CIFRE PhD thesis started December 2015 with Safran Tech. The student is Mrs Perle Geoffroy who is working on "topology optimization by the homogenization method in the context of additive manufacturing".
- A CIFRE PhD thesis started April 2017 with Safran Tech. The student is M. Florian Feppon who is working on "topology optimization for a coupled thermal-fluid-structure system".
- A CIFRE PhD thesis started October 2017 with Renault. The student is Mrs Lalaina Rakotondrainibe who is working on "topology optimization of connections between mechanical parts".
- A CIFRE PhD thesis started November 2017 with EDF. The student is H. Girardon who is working on "level set method for eddy current non destructive testing".

7.2. Bilateral Grants with Industry

- The SOFIA project (SOLutions pour la Fabrication Industrielle Additive métallique) started in the summer of 2016. Its purpose is to make research in the field of metallic additive manufacturing. The industrial partners include Michelin, FMAS, ESI, Safran and others. The academic partners are different laboratories of CNRS, including CMAP at Ecole Polytechnique. The project is funded for 6 years by BPI (Banque Publique d'Investissement).
- G. Allaire is participating to the TOP project at IRT SystemX which started in February 2017. It is concerned with the development of a topology optimization platform with industrial partners (Renault, Safran, Airbus, ESI).
- FUI project Tandem. This three years project started in December 2012 and has been extended to September 2017 involves Bull-Amesys (coordinator), BOWEN (ERTE+SART), Ecole Polytechnique (CMAP), Inria, LEAT et VSM. It aims at constructing a radar system on a flying device capable of real-time imaging mines embedded in dry soils (up to 40 cm deep). We are in charge of numerical validation of the inverse simulator.
- FUI project Saxsize. This three years project started in October 2015 and involves Xenocs (coordinator), Inria (DEFI), Pyxalis, LNE, Cordouan and CEA. It is a followup of Nanolytix where a focus is put on SAXS quantifications of dense nanoparticle solutions.

ECUADOR Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

- Ecuador and Lemma have a bilateral contract to share the results of Stephen Wornom, Lemma engineer provided to Inria and hosted by Inria under a Inria-Lemma contract.
- Ecuador and EDF had a three months contract to study the adjoint differentiation of the hydrology code Mascaret.

GAMMA3 Project-Team

5. Bilateral Contracts and Grants with Industry

5.1. Bilateral Contracts with Industry

- The Boeing Company,
- Safran-Tech,
- Projet Rapid (DGA) avec Lemma.

IPSO Project-Team (section vide)

MATHERIALS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Contracts and grants with Industry

Many research activities of the project-team are conducted in close collaboration with private or public companies: CEA, SANOFI, IRDEP, EDF, IFPEN. The project-team is also supported by the Office of Naval Research and the European Office of Aerospace Research and Development, for multiscale simulations of random materials. All these contracts are operated at and administrated by the École des Ponts.

MEMPHIS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Ongoing contract with the society VALOREM.

MEPHYSTO Project-Team (section vide)

MOKAPLAN Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. Optimal Transport applied to altimetric data dynamic interpolation

(S. Legrand V. Duval L. Chizat J-D. Benamou).

This collaboration between CLS and and funded by CNES intends to test on Column of Tropospheric Humidity data Optimal transportation interpolation techniques for balanced and unbalanced data.

NACHOS Project-Team (section vide)

NANO-D Project-Team (section vide)

POEMS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Contract POEMS-DGA

Participants: Eric Lunéville, Marc Lenoir, Séphanie Chaillat, Nicolas Kielbasiewicz, Nicolas Salles.

Start : 2015, End : 2018. Administrator : ENSTA.

This contract is in partnership with François Alouges and Matthieu Aussal (CMAP, Ecole Polytechnique) and concerns the improvement of Boundary Element Methods for wave propagation problems.

Contract POEMS-CEA-LIST

Participants: Marc Bonnet, Laure Pesudo.

Start : 12/01/2014, End : 11/31/2017. Administrator : CNRS.

This contract is about the coupling between high frequency methods and integral equation

Contract POEMS-EDF

Participants: Stéphanie Chaillat, Marc Bonnet, Zouhair Adnani.

Start : 12/01/2014, End : 11/31/2017. Administrator : CNRS.

This contract is about fast solvers to simulate soil-structure interactions.

RAPSODI Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

C. Cancès supervises the PhD Thesis of Nicolas Peton at IFPEN since October 15, 2015. The bilateral contract enters the framework agreement between Inria and IFPEN.

APICS Project-Team

6. Bilateral Contracts and Grants with Industry

6.1. Bilateral Contracts with Industry

6.1.1. *Contract CNES-Inria-XLIM*

This contract (reference Inria: 11282) accompanies the PhD of David Martinez and focuses on the development of efficient techniques for the design of matching network tailored for frequency varying loads. Applications of the latter to the design output multiplexers occurring in space applications will be considered.

6.1.2. *Contract BESA GmbH-Inria*

This is a research agreement between Inria (Apics and Athena teams) and the German company BESA ⁰, which deals with head conductivity estimation and co-advising of the doctoral work of C. Papageorgakis, see Section 5.1.3 . BESA is funding half of the corresponding research grant, the other half is supported by Region PACA (BDO), see Section 1 .

6.1.3. *Contract Inria-SKAVENJI*

This is a scientific consulting activity for the start-up company SKAVENJI. The latter develops an innovative and communicative device to facilitate the production and home consumption of small amounts of energy, produced by one or more local sources of renewable energy. Ongoing work consists in designing a simple controller improving the energy efficiency of the energy production while minimizing the number of charge and discharge cycles of the associated battery. The retained control strategy is based on consumption and production profiles.

⁰<http://www.besa.de/>

BIPOP Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- CIFRE PhD Thesis with Schneider Electric (Rami Sayoud), starting 01 January 2018.
- SAFRAN contract (August-December 2017) on the simulation of a weaving machine (F. Bertails-Descoubes)

COMMANDS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Safety Line

In the framework of an Ilab with startup Safety Line (<http://www.safety-line.fr>), we design tools for the optimization of fuel consumption for civil planes. A first part is devoted to the identification of the aerodynamic and thrust characteristics of the plane, using recorded data from hundreds of flights. As an illustration, Fig. 1 shows the drag and lift coefficients for a Boeing 737, as functions of Mach and angle of attack. Latest results have been presented by Cedric Rommel at [15].

A second part is optimizing the fuel consumption during the climb and cruise phases. Fig. 2 shows a simulated climb phase, along with recorded data from the actual flight. This collaboration relies significantly on the toolboxes BOCOP and BOCOPHJB developed by Commands since 2010. The resulting commercial tool OptiClimb is currently under testing in several airplane companies, totalling about a hundred actual optimized flights per day. Recent improvements include better atmosphere models and more accurate data for temperature and wind, as well as a first demonstrator for cruise flight optimization, see Fig. 3 .

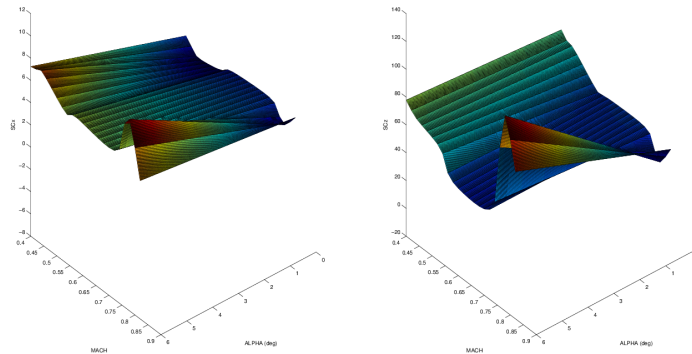


Figure 1. Lift and drag aerodynamic forces for a Boeing 737.

8.1.2. IFPEN

This study is presently conducted in the framework of the PhD of Arthur Le Rhun, started in Fall 2016. The main axis is to design a traffic model suitable for optimizing the fuel consumption of a hybrid vehicle following a given route. The first step was to develop a new traffic model in which the consumption is inferred only on the functioning points in the (speed,torque) plane. More precisely, we are interested in the probability distribution of these functioning points when considering a space/time subdivision into road segments and timeframes (see Fig.4). In order to reduce the huge number of distributions obtained, we perform a clustering step using k-means (Fig.5). Since the objects to be clustered are distributions, we choose to use the Wasserstein distance based on optimal transport. The task of computing these Wasserstein barycenters was done by Sinkhorn iterations, and we also developed a variant of stochastic gradient that scales better for huge data sets.

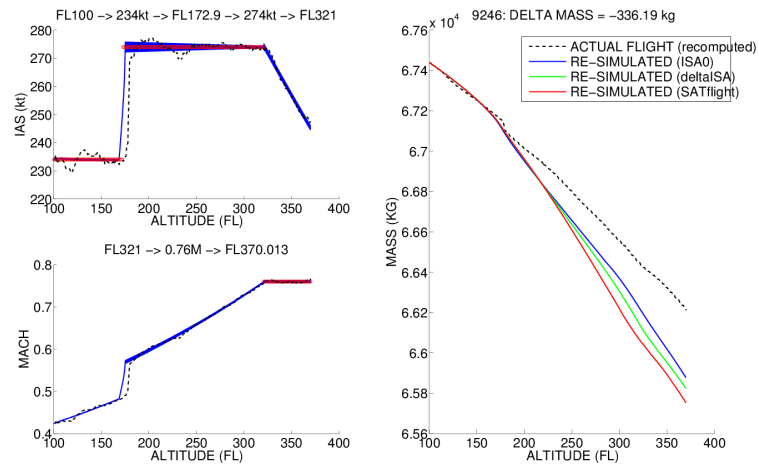


Figure 2. Simulated climb phase vs actual flight data

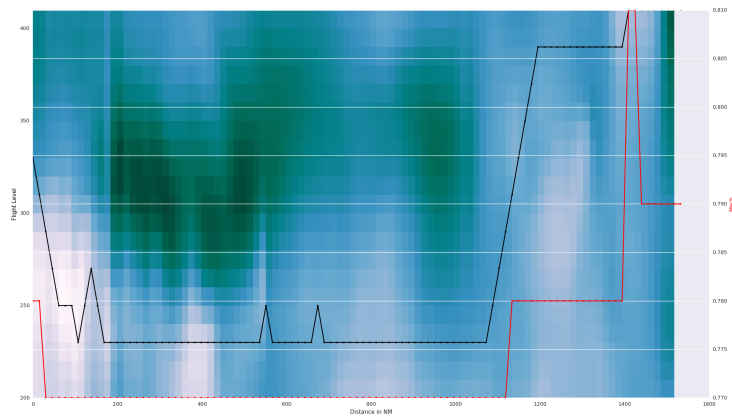


Figure 3. Simulated cruise flight (altitude in black, mach speed in red, wind speed in background)

In order to obtain the data for our traffic analysis, we work with a traffic simulator called SUMO, with the LUST scenario modeling the city of Luxembourg (<http://sumo.dlr.de>).

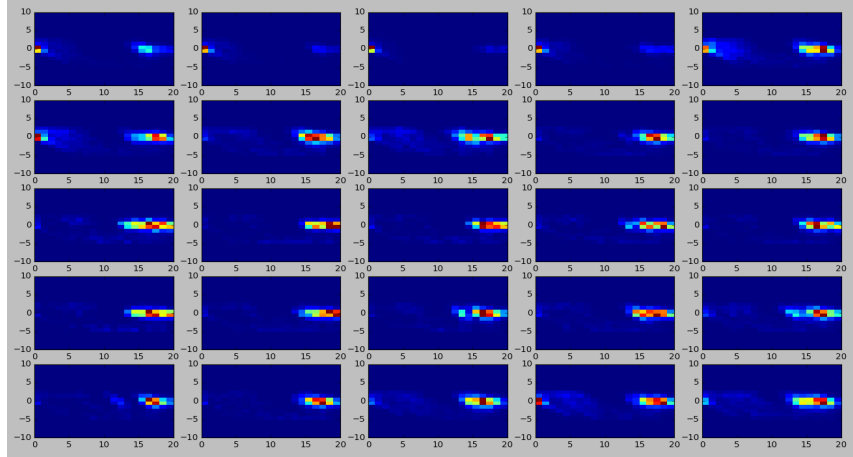


Figure 4. Distributions for all timeframes for a given road segment

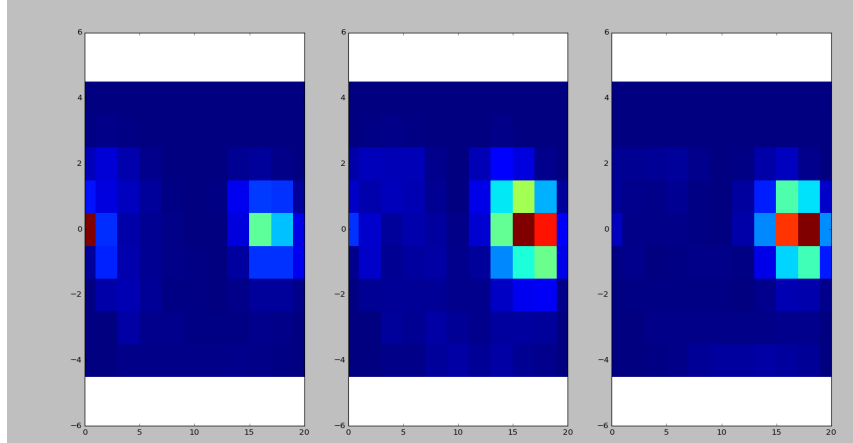


Figure 5. Barycenters after clustering ($k=3$)

DISCO Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

A collaboration with SNCF on the supervision and rescheduling of a mixed CBTC traffic on a suburban railway line is currently undergoing (CIFRE).

A collaboration with EDF on the control of renewable energy parks is undergoing (financial support of a PhD student).

A collaboration with CEA and ADEME on the modelling and control of district heating networks is undergoing (financial support of a PhD student).

GECO Project-Team (section vide)

I4S Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. *Contracts with SVS*

Participants: Laurent Mevel, Michael Doehler.

I4S is doing technology transfer towards SVS to implement I4S technologies into ARTEMIS Extractor Pro. This is done under a royalty agreement between Inria and SVS .

In 2014, the damage detection toolbox has been launched http://www.svibs.com/products/ARTEMIS_Modal_Features/Damage_Detection.aspx.

In 2015, SVS and Inria have earned an Innobooster grant to help transfer algorithms in 2016 Artemis Extractor Pro.

In 2016, uncertainty quantification for modal analysis has been launched.

In 2017, a new Innobooster grant has been obtained for the uncertainty analysis of mode shapes in Artemis.

8.1.2. *Contract with SNCF: DEMETER*

Participants: Vincent Le Cam, Quentin Bossard, Mathieu Le Pen.

IFSTTAR's engineers Arthur Bouche and Laurent Lemarchand are contributing to this project.

DEMETER is one of the major projects for I4S in terms of strategy, scientific and technological impact.

DEMETER is a meta project whose global objective is the validation of the contribution of the Internet of Things (IOT) applied to the health monitoring of railway items. SNCF and IFSTTAR have signed a roadmap for safety relevant items, where wireless monitoring and smart algorithms could bring strong improvements to SNCF in terms of real-time maintenance or predictive maintenance. Those items are, amongst others:

- Crossing engine motor monitoring
- Needle motor monitoring
- Axel counter monitoring
- Train detection pedal monitoring

In each case, a prototype of a specific wireless and smart sensor is designed (that may or may not use PEGASE 2 platform), installed along railway lines in service and data are transmitted wirelessly to the cloud supervisor at IFSTTAR for evaluation in SHM algorithms.

In particular, during 2017 SNCF and IFSTTAR have performed following common works:

- finalization of the TRAIN PEDAL DETECTION instrumentation with smart sensors using new wireless and industrial IOT protocols: LoRa and Sigfox. A specific pedal is now subject of in situ test led by SNCF
- axel counter monitoring has been the major R&D subject of 2017: 2 entire and specific smart sensors have been designed, programmed and installed at Chevilly specific SNCF testbench (e.g. with real train passages). Specific algorithms (such as PID and Pattern Recognition) have been modeled and programmed into PEGASE2 platform for these new sensors.

For the future, new projects related to

- water-level monitoring around railways has been setup
- ballast vibration monitoring of railways has been setup
- "unshunting of electrical lines at train passage" detection around railways

have been initiated with SNCF R&D department.

8.1.3. *Contracts with SDEL-CC (VINCI Group)*

Participants: Vincent Le Cam, Mathieu Le Pen.

This work was done in collaboration with Laurent Lemarchand, and Arthur Bouche at IFSTTAR, SII, Nantes. Following a 2016 contract, a new contract was signed in 2017 until end 2018, with the company SDEL-CC, a 100% daughter of the VINCI Group, Energy department. The project exploits the unique time stamp capacity of the PEGASE 2 platform up to 50 nanoseconds, independently of distances in the network of PEGASE2 nodes. The synchronization capacity is employed to design a sensor prototype based on PEGASE 2 to time-stamp the current wave after a lightning impact on a high-voltage line. By knowing the exact time, the wave can be seen at each extremity of the electrical line to localize accurately the lightning impact point.

During 2017, a real high-voltage electrical line has been instrumented: at each end of the line, 2 sensors have been set up and data are sent in real time to a cloud platform. Furthermore, the software of the platform was optimized: at the embedded level (i.e. on PEGASE 2 wireless system) with new algorithms to correct time synchronization up to some 10 nanoseconds, at the cloud level with a specific QT C++ Interface to display results (i.e. lightning localization on electrical line) and to transform raw data into ComTrade standard representation

Discussions are ongoing with SDEL-CC to transform the prototype into a future product. In 2017 it has to be mentioned that the project has been submitted to VINCI International challenges (over 150 000 collaborators) and has been awarded with The Best Vinci Innovation Award.

8.2. Bilateral Grants with Industry

8.2.1. *PhD project with EDF – Electrical device ageing monitoring*

Participants: Nassif Berrabah, Qinghua Zhang.

A joint PhD project between Inria and EDF (Electricité de France) was started in December 2014 and finished in November 2017 with Nassif Berrabah's PhD thesis defense. The purpose of this study is to develop methods for the monitoring of electrical instruments in power stations, in order to prevent failures caused by ageing or accidental events. This project has been funded by EDF and by the ANRT agency. The main outcome of this project is an efficient reflectometry-based method for resistive fault detection, localization and quantification, capable of dealing with both distributed and localized faults, with associated data processing tools taking into account practical constraints in industrial applications. These results have led to a patent jointly filed by EDF and Inria.

MCTAO Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contract with Industry: CNES - Inria - UB Contract

Contract number: 130777/00. Call Number: R-S13/BS-005-012

"Perturbations and averaging for low thrust" (Poussée faible et moyennation).

Research contract between CNES and MCTAO (both the Inria and the Université de Bourgogne parts). It run from 2014 till mid-2017. It concerned averaging techniques in orbit transfers around the earth while taking into account many perturbations of the main force (gravity for the earth considered as circular). The objective was to validate numerically and theoretically the approximations made by using averaging, and to propose methods that refine the approximation. It has co-funded the PhD thesis of Jérémy Rouot (defended in October, 2016, also co-funded by Région PACA) and fully funded the postdoc of Florentina Nicolau and 2016 [9], [8] and the postdoc of Lamberto dell'Elce this year.

NECS Project-Team (section vide)

NON-A Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Contract with Neotrope (Tourcoing, France), Technologies & Augmented Human UX. Subject: De-correlation of GSR measurements with acceleration, from March 2016 to September 2016, D. Efimov, R. Ushirobira.

8.2. Bilateral Grants with Industry

Project of Autonomous control of clinic table with La Maison Attentive, 2016.

8.3. Bilateral Grants with Industry

Collaboration with Safran Electronics & Defense (Massy-Palaiseau) in the framework of the CIFRE PhD thesis of Guillaume Rance on robust stabilization of gyrostabilized platforms (2014-2018).

QUANTIC Project-Team (section vide)

SPHINX Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

From February 2018, T. Chambrion will be the advisor of Ayoub Lasri for a PhD thesis (CIFRE label pending) on the stabilization of the Mosel river funded by *Voies Navigables de France*. This thesis is part of an international cooperation with BAW (the German counterpart of VNF, based in Karlsruhe) and Universität Stuttgart started in November 2017.

TROPICAL Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- Yield management methods applied to the pricing of data traffic in mobile networks. CRE (research contract) with Orange Labs (Orange Labs partner: Mustapha Bouhtou).
- Decentralized mechanisms of operation of power systems: equilibria and efficiency. A collaboration started on this topic at the fall, Nadia Oudjane, Olivier Beaude, and Riadh Zorgati from EDF-labs. This leads to the PhD work of Paulin Jacquot, supervised by Stéphane Gaubert (CIFRE PhD).

DOLPHIN Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

The Dolphin team has many bilateral contracts and grants with industry:

1. Beckman (2015-2018): the goal of this contract concerns the strategic and operational planning for medical laboratories (Phd of Sohrab Faramarzi).
2. PIXEO (2014-2018): the objective of this bilateral project is the predictive models and knowledge extraction for insurance web comparator (Phd of A-L. Bedenel).
3. Alicante (2014-2017): the objective of this CIFRE contract is the design of new optimization methods to extract knowledge from hospital data (Phd of M. Vandromme - defended in June 2017).
4. ONERA and CNES (2016-2020): this collaboration deals with the multi-disciplinary and multi-objective design of aerospace vehicles (Phd of J. Pelamatti and A. Hebbal).
5. Intel (2017) Bilateral academic and research partnership between Université Lille 1 and Intel. In this context, Intel provides Lille 1 with training (Dec 14th) and technical support help for the dissemination of its activities related to High Performance Computing.
6. Strat&Logic (2012-2017): the objective of this CIFRE contract is the optimization of economic decisions in a competitive business management simulator (Phd of S. Dufourny - Defended in October 2017).

GEOSTAT Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- Three year contract with I2S company on the transfert of award winning H. Badri PhD results (AFRIF PhD price in 2016). The contract is being transformed in 2018 in the form of an Inria Innovation Lab. The Innovation Lab is focused on non convex optimization methods in image processing and digital acquisition devices. People involved in GEOSTAT: H. Yahia, N. Brodu, K.Daoudi, M. Martin, A. Zebadua.

8.2. Bilateral Grants with Industry

- Transfert in the analysis of hearbeat data. Discussion and collaboration with Cardiologs company <https://cardiologs.com/>.
- Contacts for a partnership strategy on heartbeat database utilization with Parly II Hospital (F. Halimi).
- Patent 185 "Dispositif analyseur de rythme cardiaque" extended for France in 2018.

INOCS Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Fluxys (2016-2018). Study of optimization problems arising in the management of gas networks.

HappyChic (2017). Study of optimization problems arising in the warehouse management context.

Keolis (2017). Study of optimization problems arising in the management of mediation officers in public transportation.

8.2. Bilateral Grants with Industry

PARROT (Planning Adapter performing ReRouting and Optimization of Timing), part of BEWARE Fellowships Academia funded by the COFUND program of the European Union (FP7 - Marie Curie Actions). INFRABEL is the industrial partner of this project (2014-2018).

Design and Pricing of Electricity Services in a Competitive Environment within the Gaspard Monge Research Program (PGMO) funded by the Fondation Mathématiques Jacques Hadamard. EDF is the industrial partner (2015-2018).

BENMIP: A generic bender decomposition-based (mixed) integer programming solver within the Gaspard Monge Research Program (PGMO) funded by the Fondation Mathématiques Jacques Hadamard (2015-2017).

Robust Energy Offering under Market Equilibrium Constraints within the Gaspard Monge Research Program (PGMO) funded by the Fondation Mathématiques Jacques Hadamard. EDF is the industrial partner (2017-2018).

8.3. Inria Innovation Lab

COLINOCS is an Inria Innovation Lab between Colisweb, a start-up company addressing last-mile delivery and INOCS, which was created at the end of 2016. This collaboration roots back to 2015, when a bilateral contract was devoted to optimization problems arising in courier scheduling. The main objective of this Innovation Lab is to model and solve optimization problems related to revenue management, transport mutualization, a better visibility on their activities for the couriers. See also: <https://www.inria.fr/innovation/transfert-technologique/labos-communs-inria-pme/inria-innovation-labs/colinocs>

MISTIS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

CIFRE PhD with SCHNEIDER (2015-2018). F. Forbes and S. Girard are the advisors of a CIFRE PhD (T. Rahier) with Schneider Electric. The other advisor is S. Marié from Schneider Electric. The goal is to develop specific data mining techniques able to merge and to take advantage of both structured and unstructured (meta)data collected by a wide variety of Schneider Electric sensors to improve the quality of insights that can be produced. The total financial support for MISTIS is of 165 keuros.

PhD contract with EDF (2016-2019). S. Girard is the advisor of a PhD (A. Clément) with EDF. The goal is to investigate sensitivity analysis and extrapolation limits in extreme-value theory with application to extreme weather events. The financial support for MISTIS was of 140 keuros

Contract with VALEO. S. Girard and A. Clément are involved in a study with Valeo to assess the relevance of extreme-value theory in the calibration of sensors for autonomous cars. The financial support for MISTIS was of 15 keuros.

Contract with PIXYL P. Rubini was hired for 18 months for a software valorization task regarding brain MRI segmentation. The financial support for MISTIS was of 63.5keuros

MODAL Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Florimond Desprez

Participant: Guillemette Marot.

Florimond Desprez is a company which breeds plant varieties and produces seeds, spreading its innovations across the different sectors of agriculture. This 2 months contract aimed at selecting candidate markers explaining the relationship between genotypes, organoleptic and nutritional qualities of chicory. It is a joint work with Quentin Grimonprez (InriaTech engineer).

8.2. Arcelor-Mittal

Participants: Christophe Biernacki, Vincent Vandewalle.

Arcelor-Mittal is a leader company in steel industry. This 11 months contract (which began in 2016) aims at optimizing predictive maintenance from mixed data (continuous, categorical, functional) provided by multiple sensors disseminated in steel production lines. Several thousands of sensors are simultaneously involved in this study, most of them providing functional (chronological) values.

It is a joint work with Quentin Grimonprez and Vincent Kubicki (InriaTech engineers).

8.3. Alstom

Participants: Christophe Biernacki, Benjamin Guedj, Vincent Vandewalle.

Alstom is a world leader company in integrated transport systems. This 10 months contract aims at optimizing predictive maintenance in rail switches from complex data, in particular chronological ones.

It is a joint work with Etienne Goffinet (InriaTech engineer).

8.4. Vallourec

Participant: Christophe Biernacki.

Vallourec is a world leader in premium tubular solutions for the energy markets and for other demanding industrial applications. This 9 months contract (which began in 2016) aims at predicting quality of tubular connections from mixed data (continuous, categorical, functional).

It is a joint work with Etienne Goffinet and Vincent Kubicki (InriaTech engineers).

8.5. Running Care

Participant: Christophe Biernacki.

Running Care is a young company providing sport and medical coaching, and personalized healthy advices, for injury prevention. It is based on a mobile and watch app that collects sports and medical data to make them smart. This 8 months contract aims at predicting injury risks for the runner based on past runs and planned ones. It uses also many other available information that the runner can provide through the app.

It is a joint work with Quentin Grimonprez (InriaTech engineer).

RANDOPT Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Grants and Contracts with Industry

- CIFRE-DGA with Thales, for the PhD of Konstantinos Varelas (2017—2020)
- contract with Storengy to finance a part of the PhD of Cheikh Touré (2017—2020)

REALOPT Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Collaboration with EDF on robust maintenance planning

Our project with EDF concerns the optimization of the long term energy production planning, allowing for nuclear power plants maintenance. The challenges are to handle the large-scale instance of a five year planning and to handle the stochastic aspects of the problem: the stochastic variation of the electricity demand, the production capacity and the duration of maintenance period. The key decisions to be optimized are the dates of outages (for maintenance) and the level refuelling that determines the production of the year to come. We previously developed a column generation approach based on extended formulation which enables to solve within a few minutes a deterministic instance of the problem, which is within the time frame of the operational tools currently used by EDF. We now investigate stochastic and robust versions of the problem, where the duration of maintenance operations and the power demand are uncertain. Our approaches shall be evaluated on real life instances within a rolling horizon framework.

8.2. Collaboration with ERTUS on phytosanitary treatment planning

In planning winery operations (most importantly phytosanitary treatments on the wine tree) under weather forecast uncertainty, one searches for solutions that remain feasible and “cheap” in case of perturbation in the data. We consider the planning and scheduling of the operations that arise over a one-year horizon. More precisely, the operations to be scheduled include tasks related to soil care, or grape tree care: cutting, line building, thinning out leaves, ..., and chemical treatments. The latter are a main focus of our study since one of the principal goals of better planning is to reduce the amount of chemical treatments by selecting the appropriate products and schemes, but also by spacing out treatments while guarantying a disease free vineyard with some confidence. Each of the scheduled tasks requires its own resource, so the planning also triggers equipment and raw products selection decisions. The objective is to minimize both equipment and product costs augmented by an evaluation of the hazard of chemical product use. The planning should be “robust” to seasonal variations on the proper time frame for scheduling tasks.

8.3. Collaboration with St-Gobain Recherche on glass cutting

Through the PhD of Quentin Viaud, we study a hard glass-cutting problem. The objective is to minimize the quantity of trim loss when rectangular pieces are cut from large rectangles. This first study has shown that our methodologies are able to cope with this problem for medium-size instances. Solving the problem with large instances is a scientific challenge that we will address in the a follow-up contract.

8.4. Collaboration with SNCF on timetable and rolling stock rotation planning

Our projet with SNCF concerns the optimisation of timetable and rolling stock rotation planning. The railway production planning process combines heterogeneous resources and is usually decomposed into different sequential sub-problems, beginning by line planning, timetabling, rolling stock rotations and crew scheduling. Our goal is to solve the timetable and rolling stock problems in an integrated manner. Given a line planning and service requirement constraints, the problem is to produce a timetable for a set of trains and the objective is to minimize the cost of the railcars used. An originality of our approach is to deal with railcars composed of multiple units, which can be coupled or decoupled at some stations. The PhD thesis of Mohamed Benkirane is funded by this project.

SELECT Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Contract with NEXTER

Participants: Gilles Celeux, Florence Ducros, Patrick Pamphile.

SELECT has a contract with Nexter regarding modeling the reliability of vehicles.

7.2. Bilateral Grants with Industry

Benjamin Auder and Jean-Michel Poggi are participants in the grant PGMO-IRSDI, in the *Research Initiative In Industrial Data Science* context, on the subject: Disaggregated Electricity Forecasting using Clustering of Individual Consumers.

SEQUEL Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. *Lelivrescolaire.fr*

- contract with <http://Lelivrescolaire.fr>; PI: Michal Valko
Title: Sequential Machine Learning for Adaptive Educational Systems
Duration: Mar. 2018 – Feb. 2021

Abstract: Adaptive educational content are technologies which adapt to the difficulties encountered by students. With the rise of digital content in schools, the mass of data coming from education enables but also ask for machine learning methods. Since 2010, Lelivrescolaire.fr has been developing some learning materials for teachers and students through collaborative creation process. For instance, during the school year 2015/2016, students has achieved more than 8 000 000 exercises on its homework platform Afterclasse.fr. Our approach would be based on sequential machine learning: the algorithm learns to recommend some exercises which adapt to students gradually as they answer.

Participants: Julien Seznec, Alessandro Lazaric, Michal Valko.

8.1.2. *OtherLang*

- contract with “OtherLang”; PI: Romaric Gaudel
Title: Tool to support foreign language practice
Duration: 2 months

Abstract: OtherLang develops an application to learn a foreign language by reading documents and interacting wit other people. During the time-line of the contract, SequeL brought his knowledge about Recommender Systems which may be used either to recommend documents to users or to recommend users to users.

Participants: Romaric Gaudel, Philippe Preux.

8.1.3. *Sidexa*

- contract with “Sidexa”; PI: Jérémie Mary and then Philippe Preux
Title: vision applied to the segmentation and recognition of car body parts parts
Duration: 3 months

Abstract: We investigate deep learning to perform car body segmentation. The result being very good, a second contract will follow up this one in 2018.

Participants: Jérémie Mary, Philippe Preux.

8.1.4. *Renault*

- contract with “Renault”; PI: Philippe Preux
Title: State of the art in reinforcement learning regarding autonomous car control and path planning.
Duration: 3 months (Jan–Mar 2017)

Abstract: This work has consisted in surveying the litterature related to autonomous car control, and reinforcement learning.

Participants: Alexis Martin, Odalric Maillard, Philippe Preux.

- contract with Renault; PI: Philippe Preux

Title: Control of an autonomous vehicle

Duration: 3 years (12/2017–11/2020)

Abstract: This contract comes along the CIFRE grant on the same topic. This work is done in collaboration with the NON-A team-project.

Participants: Édouard Leurent, Odalric Maillard, Philippe Preux.

8.1.5. Critéo

- contract with “Criteo”; PI: Philippe Preux

Title: Computational advertizing

Duration: 3 years (12/2017–11/2020)

Abstract: This contract comes along the CIFRE grant on the same topic. The goal is to investigate reinforcement learning and deep learning on the problem of ad selection on the Internet.

Participants: Philippe Preux, Kiewan Villatell.

8.1.6. Orange Labs

- contract with “Orange Labs”; PI: Philippe Preux

Title: Sequential Learning and Decision Making under Partial Monitoring

Duration: Oct. 2014 – Sep. 2017

Abstract: This contract comes along the CIFRE grant on the same topic. In applications such as recommendation systems, or computational advertising, the return collected from the user is partial: (s)he clicks on one item, or no item at all. We study this setting in which only a “partial” information is gathered in particular how to learn to behave optimally in such a setting.

Participants: Pratik Gajane, Philippe Preux.

8.1.7. Orange Labs

- contract with “Orange Labs”; PI: Olivier Pietquin

Title: Inter User Transfer in dialogue systems

Duration: 3 years

Abstract: This contract comes along the CIFRE grant on the same topic. The research aims at developing new algorithms to learn fast adaptation strategies for dialogue systems when a new user starts using them while we collected data from previous interactions with other users. Especially, it addresses the cold-start problem encountered when a new user faces the system, before samples can be collected to optimize the interaction strategy.

Participants: Merwan Barlier, Nicolas Carrara, Olivier Pietquin.

8.1.8. 55

- contract with “55”; PI: Jérémie Mary

Title: Novel Learning and Exploration-Exploitation Methods for Effective Recommender Systems

Duration: Oct. 2015 – Sep. 2018

Abstract: This contract comes along the CIFRE grant on the same topic. In this Ph.D. thesis we intend to deal with this problem by developing novel and more sophisticated recommendation strategies in which the collection of data and the improvement of the performance are considered as a unique process, where the trade-off between the quality of the data and the performance of the recommendation strategy is optimized over time. This work also consider tensor methods (one layer of the tensor can be the time) with the goal to scale them at RS level.

SIERRA Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

Microsoft Research: “Structured Large-Scale Machine Learning”. Machine learning is now ubiquitous in industry, science, engineering, and personal life. While early successes were obtained by applying off-the-shelf techniques, there are two main challenges faced by machine learning in the “big data” era: structure and scale. The project proposes to explore three axes, from theoretical, algorithmic and practical perspectives: (1) large-scale convex optimization, (2) large-scale combinatorial optimization and (3) sequential decision making for structured data. The project involves two Inria sites (Paris and Grenoble) and four MSR sites (Cambridge, New England, Redmond, New York). Project website: <http://www.msr-inria.fr/projects/structured-large-scale-machine-learning/>.

7.2. Bilateral Grants with Industry

- A. d’Aspremont: AXA, "mécénat scientifique, chaire Havas-Dauphine", machine learning.
- F. Bach: Gift from Facebook AI Research.

TAU Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- **Thales Research & Technology** 2014-2017 (30 kEuros), related to Nacim Belkhir's CIFRE PhD
Coordinator: Marc Schoenauer
Participants: Johann Dréo, Pierre Savéant, Nacim Belkhir
- **ESA Tender** 2016-2017 (52 kEuros)
Coordinator: Bart Boonacker (TNO)
Participant: Marc Schoenauer, Dejan Tusar
- **Réseau Transport d'Electricité** 2015-2018 (72 kEuros), related to Benjamin Donnot's CIFRE PhD
Coordinator: Olivier Teytaud (until May 2016), now Isabelle Guyon
Participants: Benjamin Donnot, Antoine Marot, Marc Schoenauer
- **Therapixel** 2017 (6 mois, 3 kEuros), on the topic of 3D medical image non-rigid registration with neural networks
Coordinators: Guillaume Charpiat, Olivier Clatz
Participant: Priyanka Mandikal (master internship)
- **Myndblue**, 2017-2018 (1 an, 50kEuros) related to consulting activities with DMH (Digital for Mental Health).
Coordinator: Aurélien Decelle
Participants: all TAU members
- **La Fabrique de l'Industrie** 2017-2018 (1 an, 30kEuros) A COMPLETER (Michèle ?)
- **Renault (POC)** 2017-2018 (125 kEuros), *Clusterisation et optimisation de scenarii pour la validation des véhicules autonomes*
Coordinator: Marc Schoenauer and Philippe Reynaud (Renault)
Participants: Guillaume Charpiat, Raphaël Jaiswal (engineer), Marc Schoenauer
- **Renault (CIFRE)** 2017-2020 (45 kEuros), related to Marc Nabhan's CIFRE PhD *Sûreté de fonctionnement d'un véhicule autonome - évaluation des fausses détections au travers d'un profil de mission réduit*
Coordinator: Hiba Hage and Yves Tourbier (Renault)
Participants: Guillaume Charpiat, Marc Nabhan (PhD), Marc Schoenauer
- **RESTO** 2017 (14k Euros), *REseaux et Simulations : usages Technologiques et Opinions multiples sur les plateformes numériques dans les marchés de la restauration*, funded by Mission Interdisciplinarité of CNRS. Supported the internship of J. Posada.
Coordinator: Paola Tubaro
Participants: Philippe Caillou (with partners at Telecom ParisTech and Université Paris-Dauphine).
- **OPLa** 2017-2018, Organizing Platform Labor (27k euros), funded by Force Ouvrière.
Coordinator: A.A. Casilli (Telecom ParisTech)
Participants: Paola Tubaro
- **DiPLab** 2017-2018, Digital Platform Labor (24k euros), funded by MSH Paris-Saclay.
Coordinators: Paola Tubaro (avec A.A. Casilli, Telecom ParisTech)

ASPI Team

6. Bilateral Contracts and Grants with Industry

6.1. Bilateral grants with industry

See 4.1 .

6.1.1. Hybrid indoor navigation — PhD project at CEA LETI

Participants: François Le Gland, Kersane Zoubert–Oussen.

This is a collaboration with Christophe Villien (CEA LETI, Grenoble).

The issue here is user localization, and more generally localization-based services (LBS). This problem is addressed by GPS for outdoor applications, but no such general solution has been provided so far for indoor applications. The desired solution should rely on sensors that are already available on smartphones and other tablet computers. Inertial solutions that use MEMS (microelectromechanical system, such as accelerometer, magnetometer, gyroscope and barometer) are already studied at CEA. An increase in performance should be possible, provided these data are combined with other available data: map of the building, WiFi signal, modeling of perturbations of the magnetic field, etc. To be successful, advanced data fusion techniques should be used, such as particle filtering and the like, to take into account displacement constraints due to walls in the building, to manage several possible trajectories, and to deal with rather heterogeneous information (map, radio signals, sensor signals).

The main objective of this thesis is to design and tune localization algorithms that will be tested on platforms already available at CEA. Special attention is paid to particle smoothing and particle MCMC algorithms, to exploit some very precise information available at special time instants, e.g. when the user is clearly localized near a landmark point.

In some applications, real time estimation of the trajectory is not needed, and a post processing framework may provide a better estimation of this trajectory. In [57], we present and compare three different algorithms to improve a real time trajectory estimation. Actually, two different smoothing algorithms and the Viterbi algorithm are implemented and evaluated. These methods improve the regularity of the estimated trajectory by reducing switches between hypotheses.

Post processing indoor navigation is interesting, for example to develop crowdsourcing analysis. The post processing framework allows to provide a better estimation than in a real time framework. The main contribution of [17] is to present a piecewise parametrization using IMU (inertial measurement unit) and RSS (received signal strength) measurements only, which lead to an optimization problem. A Levenberg–Marquardt algorithm improved with simulated annealing and an adjustment of RSS measurements data leads to a good estimation (55% of the error less than 5 meters) of the trajectory.

6.1.2. Bayesian tracking from raw data — CIFRE grant with DCNS Nantes

Participants: François Le Gland, Audrey Cuillery.

This is a collaboration with Dann Laneuville (DCNS Nantes).

After the introduction of MHT (multi-hypothesis tracking) techniques in the nineties, multitarget tracking has recently seen promising developments with the introduction of new algorithms such as the PHD (probability hypothesis density) filter [50], [56] or the HISP (hypothesised filter for independent stochastic populations) filter [40]. These techniques provide a unified multitarget model in a Bayesian framework [54], which makes it possible to design recursive estimators of a *multitarget probability density*. Two main approaches can be used here: sequential Monte Carlo (SMC, also known as particle filtering), and Gaussian mixture (GM). A third approach, based on discretizing the state-space in a possibly adaptive way, could also be considered despite its larger computational load. These methods are well studied and provide quite good results for *contact output*

data, which correspond to regularly spaced measurements of targets with a large SNR (signal-to-noise ratio). Here, the data is processed (compared with a detection threshold) in each resolution cell of the sensor, so as to provide a list of detections at a given time instant. Among these methods, the HISP filter has the best performance/computational cost ratio.

However, these classical methods are unefficient for targets with a low SNR, e.g. targets in far range or small targets with a small detection probability. For such targets, preprocessing (thresholding) the data is not a good idea, and a much better idea is to feed a tracking algorithm with the raw *sensor output* data directly. These new methods [24] require a precise modeling of the sensor physics and a direct access to the radar (or the sonar) raw data, i.e. to the signal intensity level in each azimuth/range cell. Note that these new methods seem well suited to new types of sensors such as lidar, since manufacturers do not integrate a detection module and do provide raw images of the signal intensity level in each azimuth/range cell.

The objective of the thesis is to study and design a tracking algorithm using raw data, and to implement it on radar (or sonar, or lidar) real data.

CQFD Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. DCNS

Participants: Huilong Zhang, Jonatha Anselmi, François Dufour, Dann Laneuville.

The increasing complexity of warfare submarine missions has led DCNS to study new tactical help functions for underwater combat management systems. In this context, the objective is to find optimal trajectories according to the current mission type by taking into account sensors, environment and surrounding targets. This problem has been modeled as a discrete-time Markov decision process with finite horizon. A quantization technique has been applied to discretize the problem in order to get a finite MDP for which standard methods such as the dynamic and/or the linear programming approaches can be applied. Different kind of scenarios have been considered and studied.

8.1.2. Thales Optronique

Participants: Benoîte de Saporta, François Dufour, Alizée Geeraert.

Maintenance, impulse control, failure, optimization. The objective of this grant in collaboration with Thales Optronique was to optimize the maintenance of a multi-component equipment that can break down randomly. The underlying problem was to choose the best dates to repair or replace components in order to minimize a cost criterion that takes into account costs of maintenance but also the cost associated to the unavailability of the system for the customer. This industrial process has been modeled by a piecewise deterministic Markov process (PDMP) and the maintenance problem has been formalized as an impulse control problem. We have applied an approximation method based on a quantization technique of the post jump location and inter-arrival time Markov chain naturally embedded in the PDMP, and a path-adapted time discretization grids to get an approximation of the value function. We have shown the existence of control strategies that can outperform reference control policies used by Thales Optronique. It remains to provide the explicit form of such strategies. This is actually the objective of a new collaboration with Thales Optronique that started in October 2017 funded by the Fondation Mathématique Jacques Hadamard.

8.1.3. Lyre: ADEQWAT project

Participants: François Dufour, Alexandre Genadot, Jérôme Saracco.

Stochastic modelling, Optimization. This project has just started in November 2017. The topic of this collaboration with Lyre, l'Agence de l'eau Adour-Garonne and ENSEGID is the modeling of the uncertainties in the Water demand adequacy in a context of global climate change. A PhD thesis (2018-2021) is part of this project.

MATHRISK Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Grants with Industry

- Consortium PREMIA, Natixis - Inria
- Consortium PREMIA, Crédit Agricole CIB - Inria

7.2. Bilateral Contracts with Industry

- Chair Ecole Polytechnique-ENPC-UPMC-Société Générale "Financial Risks" of the Risk fondation . Participants: A. Alfonsi, B. Jourdain, B. Lapeyre
- AXA Joint Research Initiative on Numerical methods for the ALM, from September 2017 to August 2020, Participant: A. Alfonsi.

TOSCA Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- M. Deaconu is involved in a bilateral contract with Venathec. She is supervising, with E. Vincent (EPI Multispeech), the Ph.D. thesis of B. Dumortier on the acoustic control of wind farms noise.

8.2. Bilateral Grants with Industry

- M. Bossy is member of a MERIC project (MERIC is the marine energy research & innovation center in Chile) on stochastic Lagrangian models to better estimate energy production variability with water turbine, granted with the Lemon Inria Team.
- M. Bossy is the Coordinator of the TER project from the PGMO (FMJH) granted with the SME METIGATE, on the statistical description of coupled regional temperatures. D. Talay also participates to this project.
- M. Bossy is the Coordinator of the SPARE projet at UCA-JEDI on Monte Carlo approaches for the simulation of particles transport in a flow, with EDF and Observatoire de la Côte d'Azur.
- M. Bossy is the Coordinator of the POPART Industrial partnership projet at UCA-JEDI on the modeling of fiber transport in turbulent flow. This partnership is granted by EDF and by UCA, and in collabiration with Observatoire de la Côte d'Azur.